Dissertation On

THE EVALUATION OF BLOOD PRESSURE IN SCHOOL CHILDREN AGED 12-16 YEARS

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CERTIFICATE

Certified that this **DISSERTATION** entitled **THE EVALUATION OF BLOOD PRESSURE IN SCHOOL CHILDREN AGED** 12-16 Years is a bonafide work done by **Dr. N. BALAKRISHNAN.** Post Graduate, Kilpauk Medical College, Chennai during the academic year 2003-2006

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CONTENTS

INTRODUCTION

Recent emphasis on Hypertension and its possible origin during childhood has served as an impetus for paediatricians to routinely include measurement of Blood Pressure as an integral part of paediatric physical examination. In the hospitalised patient it is considered an important and routine as documentation of body temperature, pulse rate and respiratory rate. In the out patient clinics it is now common practice to measure and record the B.P. in all children above 3 years of age.

Blood pressure is a reflection of cardiac output, peripheral vascular resistance, blood volume, arterial elasticity, and other hemodynamic variables. Readings considered to be abnormal therefore have wide-spread implications and determine the basis for further investigation of a number of systems which influence the level of blood pressure. Thus the accuracy of blood pressure measurement has assumed a portion of primary importance since an error in the other direction may lead to neglect of an important underlying problem.

The measurement of blood pressure is an estimate rather than a precise determination since a number of physiologic variations, some of which cannot be controlled are operative. Systolic arterial pressure varies diurnally with an early morning low point and an early evening high point. With complete bed rest as in sound sleep the systolic pressure decreases. After food intake a minor transient increase occurs, strong sensory stimuli arise from things such

as a distended bladder or physical activity are known to result in elevation of blood pressure. Fear, apprehension, agitation and other emotional factors tend to raise the arterial pressure. Exposure to cold may cause a decrease blood pressure where as exposure to heat may result in an increase.

Finally periodic physiologic undulations, Traube Hering waves possibly related to variation in vasomotor activity and respiratory movements. Heart rate and stroke volume may account for fluctuations which can reach a magnitude as high as 40 mm Hg in some individuals. But the knowledge of the physiologic variable directs the attention and eliminate extrinsic errors and need for more than one single measurement.

REVIEW OF LITERATURE

DEFINITION OF BLOOD PRESSURE

Blood pressure is the lateral pressure exerted by blood on the vessel walls while flowing through it.

Lateral pressure is that pressure when force is exerted at right angles to the direction of flow at any point within a tube filled with a circulating fluid. Resistance is opposite to force.

Systolic Pressure	:	The maximum pressure during systole
Diastolic Pressure	:	The minimum pressure during diastole
Pulse Pressure	:	The difference between systolic and accepted diastolic pressure
Mean Pressure	:	Diastolic pressure plus $1/3^{rd}$ of pulse pressure

PHYSIOLOGY

PHYSIOLOGICAL VARIATIONS OF BLOOD PRESSURE

a. Age

Blood Pressure rises with age. During infancy the systolic pressure is from 70 – 90 mm Hg, in children 90 – 110 mm Hg and at puberty 110 – 120 mm Hg.

b. Sex

In females both systolic and diastolic pressure are slightly lower than in males upto the age of 40 – 50 years if age.

c. Build

The systolic pressure is usually high in obese persons.

d. Exercise

In strenuous exercise the systolic pressure increases and may reach even upto 180 mm Hg and in moderate exercise there is a slight increase of systolic blood pressure.

e. Posture

The diastolic pressure is slightly higher in the standing position. In the recumbent posture the diastolic pressure is lower than the standing or in sitting position.

f. Sleep

The systolic pressure falls by about 15 – 20 mm Hg during sleep.

g. After ingestion of food

There is a slight increase of systolic pressure.

h. Emotion or Excitement

It causes increase of systolic pressure.

Factors controlling Arterial Blood Pressure

1. Pumping action of heart
2. Cardiac output
3. Peripheral resistance : It is the resistance which the blood has to overcome while passing through the periphery. The chief seat of peripheral resistance is the arterioles. It depends upon the following :
   a. Velocity of Blood
   b. Elasticity of arterial walls

c. Lumen of blood vessels

4. Elasticity of arterial walls.
5. Blood Volume
6. Viscosity of blood.

Significance of Blood Pressure

The height of systolic pressure indicates :

1. The extent of work done by heart
2. The force with which the heart is working
3. The degree of pressure which the arterial walls have to withstand.

Diastolic pressure indicates the measure of peripheral vascular resistance against which the heart has to work constantly.

The normal function of blood pressure is

1. To maintain sufficient pressure head to keep the blood flowing.
2. To provide for the motive force of filtration at the capillary. bed thus assuming nutrition to the tissue cells, formation of lymph and so on.

MEASUREMENT OF BLOOD PRESSURE

General Precautions

Errors is measurement revolve about the patient, the instrument, the technique of measurement and the examiner.

The patient

The level of arterial blood pressure both systolic and diastolic may very considerably with the phase of respiration or with the changes in cardiovascular hemodynamics. Deep breathing, crying, laughing, anxiety, recent activity and abnormal body temperature may exert profound influences. Thus it is important to reassure the patient and to allow time for recovery from apprehension or recent activity. Since the state of relaxation is generally less stable in children than adults, greater difference with consecutive measurements are often observed particularly with age group under two to four years.

The choice of Instrument

The mercury manometer is the sphygmomanometer of choice as it has the advantages of widespread general usage, reliability, accuracy and of not requiring recalibration.[1] The level of mercury at Zero cuff pressure and definition of the meniscus should be checked before measurement. Aneroid manometers are inferior to the mercury type since the former are more sensitive to jolts and mechanical errors.

Technique of Measurement

The mercury column must be vertical and the eyes of the examiner should be at the level of the meniscus. An appropriate size of the cuff should be used in the paediatric age group.

The preparation of the child is essential for the determination of blood pressure. The examining area should be quiet. The procedure is fully explained to the children and were allowed to sit for 15 minutes to recover from recent activity and apprehension. The children were examined in a comfortable sitting position with right upper arm fully exposed resting on a supportive surface at heart level. The manometer should be placed at the observer eye level. 1987 Task Force Recc.[1]

The width of the cuff

The Riva-rocci's cuff which is too narrow may result in an error on the higher side, where as one which is too wide may result in an error on the

lower side. Use of a narrow cuff requires a higher inflation pressure to compress the artery, while the use of a cuff which is too wide, a larger segment of vessel is compressed, resulting in increased resistance to flow and a tendency for the pulse to disapper before it reaches the lower edge of the cuff.

Although Moss et al.,[2] established a relatively precise index for proper cuff selection for a given child, for practical purposes it is significant merely to select a cuff which covers about two thirds of the upper arm length.

DIMENSIONS FOR APPROPRIATE SIZE CUFF

Range of Dimensions of Bladder (Cm)

Cuff Name	Width cms	Length cms
New born	2.5 – 4.0	5.0 – 10.0
Infant	6.0 – 8.0	12.0 – 13.5
Child	9.0 – 10.0	17.0 – 22.5
Adult	12.0 – 13.0	22.0 – 23.5
Large Adult Arm	15.5	30.0
Adult Thigh	18.0	36.0

Length of the cuff

The ideal cuff should have a bladder length that is 80% and a width that is at least 40% of arm circumference (length to width ratio of 2 :1).Pickering et al.,[3]

Data regarding the appropriate size cuff for measurement of Blood Pressure in the lower extremity is lacking. The common impression that arterial pressure is higher in the legs than in the arms is a misconception and probably reflects use of cuffs with inadequate width.

The cuff should be applied snugly to the bare limb. A loosely applied cuff results in ballooning of the bag and a narrowing of the effective surface.

The Examiner

Determination of blood pressure can be entrusted to physicians ability to hear the korotkoff sounds and relates them to calibrated mercury column. It is recommended that the average of at least three readings of systolic and diastolic pressure be accepted as the final estimate.[1]

METHODS OF BLOOD PRESSURE MEASUREMENT

Auscultatory method

The diaphragm of the stethoscope is firmly applied over anterior cubital fossa. It should not be in contact with the lower edge of the cuff. The cuff should be inflated rapidly by about 30mm of Hg above the systolic BP detected by palpatory method and the cuff be deflated at 2 mm Hg per Sec. Too rapid deflation rate can result in errors in either direction. Low value obtained when the rate is so fast that the various phases of the vascular sounds cannot be accurately interpreted. High values are obtained if the rapid rate of deflation creates a negative pressure above the mercury column and prevents the equalisation of pressure in the cuff and in the manometer . Inflation must be rapid since slow inflation may result in a period between systolic and diastolic pressure during which all vascular sounds disappear (auscultatory gap). The auscultatory gap may result in a profound error in interpretation of either systolic or diastolic pressure.

With cuff inflation above the peak pressure of the arterial pulse wave, the artery is completely occluded. With gradual deflation the vessel opens, the pressure pulse in transmitted to the periphery and the vascular sounds of korotkoff become audible. These can be identified as occurring in five distinct phases.

Phase I : The sudden appearance of sharp thud.

Phase II : Prolongation of the sounds in to a murmur

Phase III : Increased intensity of sounds

Phase IV : Muffling of the sounds

Phase V : Complete disappearance of the sounds

There is a Universal Agreement that phase I is the index of systolic pressure. The index of diastolic pressure is less certain and rests between muffling and cessation of the vascular sounds.

Available data indicate that in children muffling is probably the best index, but neither muffling nor cessation accurately reflects the intra arterial pressure. Muffling tends to give readings which are too high and cessation tends to give readings which are too low. The latest recommendations of the American Heart Association regards muffling as the best index of diastolic pressure.

Some attention should be directed to the measurement of blood pressure in the school going children. It is particularly here that proper selection of cuff size is crucial. It is important to recognise that although some of the cuff pressure may be dissipated by excess fatty tissue. In view of higher incidence of hypertension in these subjects, it would be a mistake to dismiss an abnormally high reading on the basis of error due to cuff size.

Other methods of Indirect Measurement

In infants measurement of Blood pressure by auscultation is often difficult or impossible and other methods of measurements must be used. A wide variety of mechanical and electronic devices have been used nowadays, but all are based on the traditional methods of auscultation, palpation or oscillometry. Whichever method of device is used all are subjected to gross inaccuracies if the precautions described earlier were not carefully adhered to. It is particularly important that the infant be quiet and relatively immobile, since movement or crying will profoundly affect the reading obtained. There is no problem in an anaesthetised or unconscious child, but in the conscious infant one may have to resort to a nipple or a pacifier even though the act of sucking may raise the level of arterial pressure to some degree.

Ultra Sound

Ware et al.,[5] described the indirect measurement of systolic pressure utilizing the Doppler principle. This method has been proved quiet reliable

and a number of devices are commercially available. Antonio Hernandez et al.,[6]

Doppler Effect

When ultrasound waves are directed towards an immobile structure, they are reflected back with no change in frequency, in the case of a moving structure such as the wall of a pulsating artery however the frequency of the reflected waves are altered. The alteration in frequency and therefore the pitch of the audible sound varies with the velocity of the blood flow. The altered frequency of the reflected sounds is amplified to produce a signal which is audible by head phone or by a speaker system, or the signal can be recorded and visualised.

The apparatus consists essentially of a small transmitting and receiving transducer which is inserted in the recess of an inflatable cuff and applied to the arm in the conventional manner. It must be applied in such a way that the transducer overlies the brachial artery. The cuff is inflated to a level which occludes the artery, and the transmitted ultrasound waves are reflected back with no change in frequency with deflation of the cuff, the vessel suddenly snaps open causing a change in frequency of the reflected waves and producing audible signals. The signals recur with each pulsation until the pressure in the cuff is lower than that in the artery. At that point, the artery remains open during the entire cardiac cycle and the ultrasonic signal

becomes muffled. This is considered the index of diastolic pressure. This is best for measuring mean arterial blood pressure.

Flush Method

In 1952 Cappe et al.,[7] and Goldring et al.,[8] measured the digital blood pressure by application of a pneumatic cuff to the wrist.

With the infant in the recumbent position, the arm cuff is applied to the arm for an upper extremity reading and to the ankle for a lower extremity reading. The extremity distal to the cuff is compressed by firmly wrapping it with a soft, wide rubber drain, an elastic bandage the purpose of which is to drain the hand or foot of blood. The wrapping should begin at the tips of the digits working proximally to the lower edge of the cuff. Compression with one hand is to be condemned, since it often produces inaccurate results because of incomplete drainage leading to poor definition of the end point. A 5 cm cuff is generally easier to work with, but it has been established that various size cuffs from 5–9.5 cm in width does not significantly affect the readings.

Following completion of compression, the cuff is inflated to 200 mm of Hg and the wrapping removed with slow release of cuff pressure a level is eventually reached at which there is a definite flushing of the blanched distal portion of the extremity. This is the end point with a deflation rate not exceeding 5 mm of Hg per sec., the end point has been found to approximate the mean arterial blood pressure.[9]

Viring et al.,[10] recognised that severe anemia, oedema and marked hypothermia may adversely affect the end point. Although there are conflicting opinions, it appears that the flush blood pressure is greater in the wrist than in the ankle during the major portion of the first year of life.

Palpatory Method

This method is the oldest of clinical methods of indirect measurement and is seldom used alone. The radial pulse is located and the pressure in the pneumatic cuff is raised well above the level at which palpable pulsations disappear, with gradual deflation of the cuff the pulsations reappear and the manometer pressure at the first palpable beat is considered as the systolic pressure. It should be pointed out that this reading is usually 5 to 10 mm Hg lower than that measured by auscultation.[11]

Visual Oscillometry

This method was first introduced in 1904 and is based on visualisation of the oscillations transmitted by the arterial pulse to the mercury column in the manometer. With cuff deflation, the levels at which the oscillations appear and disappear are read as the systolic and diastolic pressure respectively. Now-a-days this method is not in use.

Definition of Hypertension in Children

By what criteria should hypertension be defined? It has been proposed that children with systolic and or diastolic pressures are repeatedly above the

95th percentile for age and sex for 3 repeated observations over a 6 week period of time.

POTENTIALLY CURABLE FORMS OF HYPERTENSION IN CHILDREN

Renal

- Unilateral dysplastic kidney
- Unilateral hydronephrosis
- Unilateral pyelonephritis
- Traumatic damage. Constrictive perirenal hematoma
- Renal tumors and isolated cysts
- Unilateral multicystic kidney
- Unilateral ureteral occlusion
- Ask upmark kidney

Vascular

Co-Arctation of the thoracic or abdominal aorta

Abnormalities of the renal artery (stenosis, arteritis, fibromuscular dysplasia, neurofibromatosis, fistula, aneurysm) Renal vein thrombosis.

Adrenal

- Neuroblastoma,
- Pheochromocytoma
- Cortical hyperplasia (adrenogenital syndrome)
- Cushings disease
- Primany aldosteronism (hyperplasia or ademona)
- Adrenal carcinoma

Miscellaneous

- Vascular or unilateral renal parenchymal abnormalities
- After irradiation
- Ingestion of excessive amount of liquorice
- Administration of glucocorticoids

CONDITIONS ASSOCIATED WITH INCURABLE FORMS OF CHRONIC HYPERTENSION IN CHILDREN

Renal

Chronic glomerulonephritis (all forms including those due to connective tissue diseases).

- Bilateral congenital dysplastic kidneys

- Chronic bilateral pyelonephritis
- Bilateral hydronephrosis
- Polycystic kidneys
- Medullary cystic disease
- Post renal transplantation (rejection damage)

Vascular

- Surgically irremediable abnormalities of the renal artery
- Surgically irremediable Co-Arctation of the aorta, Generalised hypoplasia of aorta.

Miscellaneous

- Essential hypertension
- Renal parenchymal damage from irradiation
- Lead nephropathy (late)
- Dexamethsone suppressible hypertension
- ACTH- dependent hypertension.

CONDITIONS ASSOCIATED WITH TRANSIENT OR INTERMITTENT HYPERTENSION IN CHILDREN

Renal

- Acute post streptococcal glomerulonephritis
- Hemolytic – uraemic syndrome
- Anaphylactoid purpura with nephritis
- After renal transplant (immediate and during episodes of rejection)
- After blood transfusion in patients with azotemia

Miscellaneous

- Administration of corticosteroids (including DOCA and ACTH)
- Elevated intracranial pressure (any cause)
- After surgery especially of the genitourinary tract.
- Hypocalcemia
- Burns
- Guillian Barre Syndrome
- Poliomyelitis
- Leukemia
- Hypernatremia
- Stevens Johnson Syndrome
- Familial dysautonomia
- Acute Intermittent Porphyria
- Mercury poisoning

- Amphetamine overdosage.

Over Weight and Obesity

Adolescence is a period of transition between childhood and adulthood. It occupies a crucial position in life of human beings characterised by an exceptionally rapid rate of growth. During the past 20 yrs the prevalence of overweight and obesity among children and adolescents have doubled. Obesity in childhood is associated with an increased incidence of hypertension, diabetes, coronary artery disease, osteoarthritis, and overall increase in morbidity and mortality during adult life (Guntheroth et al.,)[12].

There is evidence that children and adolescents are becoming overweight than in the past possibly because of decreased physical activities, sedentary lifestyles, altered eating patterns .[12, 13].

AIM OF THE STUDY

Blood pressure is often a neglected procedure in school going children as compared to adults in whom it forms a routine procedure. But the prevalence of hypertension in adolescent school children reported in various literatures has encouraged us to find out the same in our population. Available data in the Indian standards are minimal and we are forced to compare our own values with the western standards. May such studies will go a long way in setting normal standards for Indian children.

A cross sectional study was undertaken for a period of one year in adolescent school children in age groups between 12-16 years. Detailed clinical examination was done in 1060 adolescent school children and blood pressure was recorded in right upper limb and correlation of blood pressure with BMI, family history of hypertension and diabetes were studied.

OBJECTIVES

To Evaluate

I. The normal range of blood pressure in adolescent school children aged 12-16 yrs.

II. Cut off point for hypertension.

III. Prevalence of hypertension in school children.

IV. Relationship of blood pressure with variables like age, body mass index (BMI) socioeconomic status and family history of hypertension and diabetes.

MATERIALS AND METHODS

The subjects of this study were adolescent school children between the ages 12-16yrs of both sexes and belonging to middle and lower socio economic groups. Age was taken in completed years and was recorded from school registers. Height was measured by using a vertical scale to the nearest 0.5 cms. Weight was measured using a standard weighing scale to the nearest 0.5 kgs. The international cut off points for body mass index were used for classifying children as overweight and obese.[14] BMI- in 85^{th} – 95^{th} percentile is called overweight and >95the percentile is obese<5^{th} percentile is underweight.[14]

The procedure was informed to all children and measures has been taken to reduce the anxiety. Their co-operation was sought specifically for information regarding hypertension, diabetes in any immediate member of the family.

One very important aspect is to familiarise the child in advance in order to reduce the anxiety associated with the measurement procedure and to avoid excitement associated with anticipation. In our study cordial atmosphere was created to do an unhurried and relaxed examination which was achieved by talking to the child and recording blood pressure as the last part of the examination procedure. The child was also made to witness similar pressure recording in other children and this helped in a large way to allay their apprehension. Prior to recording the child was asked to void urine.

Repeated measurements were obtained. These measures helped to obtain basal pressures.

The basal pressure is important because the basal pressure in adolescents seems to be a better predictor of essential hypertension in adulthood than casual blood pressure.

A sample size of 1060 school children stratified for age and sex. All children included were subjected to through clinical examination and children found to have cardiac and renal diseases were excluded from the study.

Recording of Blood Pressure

The instrument used was mercury sphygmomanometer in conjunction with a good stethoscope for all ages. The cuff sizes of 7 cm and 12 cm were used and care was taken to select an appropriate sized cuff which cover about $2/3^{rd}$ of the upper arm. All observations were made in the right arm with the child properly seated.

Site of Blood Pressure Measurement

In all the cases brachial artery was routinely felt and then the right upper limb was used for recording blood pressure as it is the direct continuation of ascending aorta.

These group of children were very co-operative and technically also feasible to hear the korotkoff sounds well with child sitting in a proper chair

and sphygmomanometer at childs heart level. Blood pressure was recorded in the right upper limb. The cuff was firmly placed over the brachial artery and inflated to 30mm above the systolic BP recorded by palpatory method, then the cuff is deflated by 2-4 mm of Hg per second.

The appearance of 1st korotkoff sound and muffling of korotkoff sounds were taken as systolic and diastolic pressure respectively. Three readings were taken at an interval of 5 minutes each and average of the 3 reading taken as systolic and diastolic blood pressure respectively.

Blood Pressure was recorded in all children from lower and middle socioeconomic groups. The socioeconomic status was assigned on the basis of socioeconomic status scale by Kuppuswami. (Annexure II). Children with blood pressure >95th percentile were referred to Govt. Royapettah Hospital for follow up.

Statistical Analysis

Descriptive (mean and standard deviation) statistics was used to analyse the data. One way analysis of variance (ANOVA) was computed to test any significant difference in BMI and BP measurement of groups. Chisquare test, 't' test, and pearsons correlation coefficient were used for significant difference in BP, BMI, Family History of Hypertension and Diabetes.

OBSERVATION

TABLE-1

Sex Distribution

Sex	No. of Children	Percentage
Male	510	48%
Female	550	52%
Total	1060	100%

TABLE -2

Age and Sex Distribution

Age in year	Male	Female	Total	Percentage
12	48	67	115	10.8
13	67	123	190	17.9
14	128	156	284	26.8
15	164	149	313	29.6
16	103	55	158	14.9
Total	510	550	1060	100

Table 1&2, shows number of cases in the different age groups. Highest no of cases studied was in age group of 15 yrs. In other groups on an average 150 cases were studied.

Figure -1

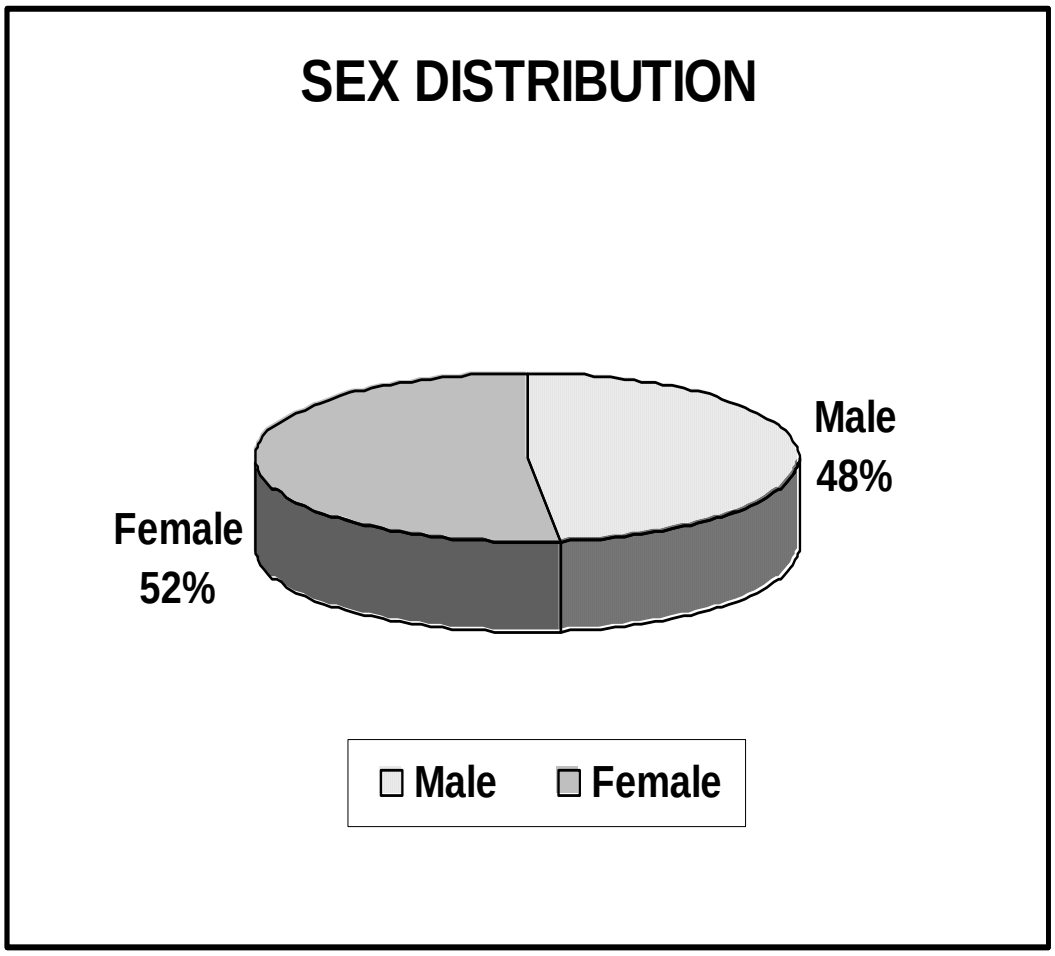

TABLE-3

Mean and percentile position for systolic BP Based on Age and Sex

Age (in yrs)	Male				Female			
	N	Mean ± SD	5th	95th	N	Mean ± SD	5th	95th
12	48	112.58±9.91	97.8	125.2	67	107.61±10.45	94.0	120.8
13	67	113.58±9.73	100	126.4	123	109.06±11.11	92.4	124.0
14	128	113.48±9.78	97.8	128.2	156	112.29±11.38	94.0	124.6
15	164	114.04±11.38	96.0	129.0	149	111.91±11.99	90	128.0
16	103	115.17±11.64	96	130.0	55	114.07±12.52	90	129.0

TABLE -4

Mean and percentile position for Diastolic BP based on Age and Sex

Age (in yrs)	Male				Female			
	N	Mean ± SD	5th	95th	N	Mea n± SD	5th	95th
12	48	74.25±5.11	67	78.2	67	69.85±8.64	64.0	76.2
13	67	73.46±6.44	68.2	79.6	123	72.23±7.76	66.0	78.4
14	128	74.84±5.72	70.6	80.4	156	73.96±7.33	64.3	79.6
15	164	74.49±6.14	71.2	81.3	149	74.03±7.49	65.6	80.0
16	103	75.05±6.16	72.6	83.8	55	76.51±6.31	70.2	82.8

Figure -2

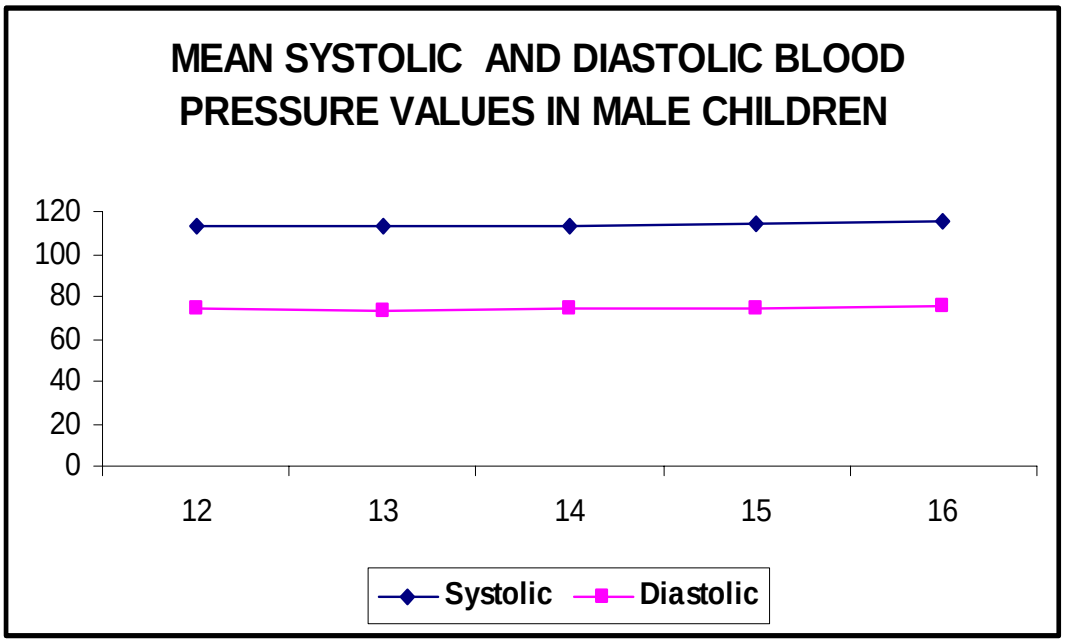
MEAN SYSTOLIC AND DIASTOLIC BLOOD PRESSURE VALUES IN MALE CHILDREN
120
100
80
60
40
20
0
12
13
14
15
16
Systolic
Diastolic

Figure -3

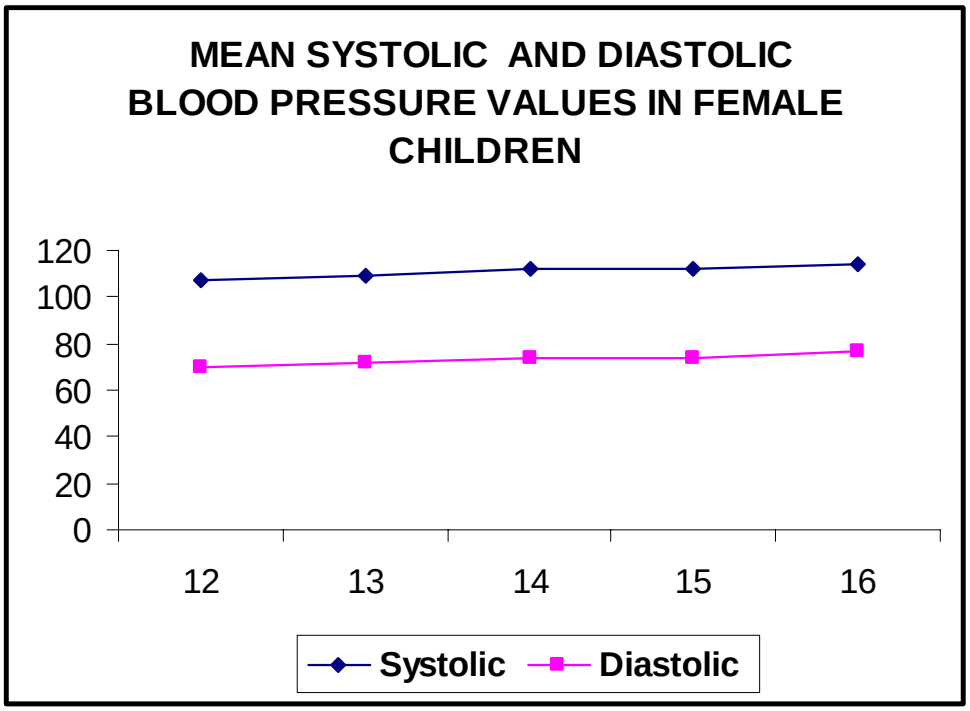
MEAN SYSTOLIC AND DIASTOLIC BLOOD PRESSURE VALUES IN FEMALE CHILDREN
120
100
80
60
40
20
0
12
13
14
15
16
Systolic
Diastolic

TABLE -5

Mean scores of BMI and Blood Pressure

Age group	Wt Kg	Height cms	BMI	Mean Sys. BP ± SD	Mean Dia BP ± SD
12	38.41	145.84	18.23	109.69±10.48	71.69±7.66
13	40.22	147.66	19.27	110.65±10.84	72.66±7.32
14	42.78	150.85	19.50	112.83±10.69	74.36±6.66
15	47.99	156.32	19.80	113.02±11.70	74.27±6.86
16	49.63	157.10	20.28	114.78±11.92	75.56±6.23

Table shows the relation between the BMI and Blood pressure. As BMI increases the systolic and diastolic presence level also increase.

TABLE -6

Mean scores weight and blood pressure of male and female children based on age

Age in yrs	Male			Female			Total		
	Wt mean ± SD	Systolic mean ± SD	Diastolic mean ± SD	Wt mean ± SD	Systolic mean ± SD	Diastolic mean ± SD	Wt mean ± SD	Systolic mean ± SD	Diastolic mean ± SD
12	35.56 ± 4.584	112.58 ± 9.91	74.25 ± 5.11	39.74 ± 8.025	107.61 ± 10.45	69.85 ± 8.64	38.41 ± 6.595	109.69 ± 10.48	71.69 ±7.66
13	39.00 ± 4.376	113.58 ± 9.73	73.46 ± 6.44	40.89 ± 7.483	109.06 ± 11.11	72.23 ± 7.76	40.22 ± 6.607	110.69± 10.84	72.66 ± 7.32
14	41.71 ± 52.86	113.48 ± 9.78	74.84 ± 5.72	43.66 ± 7.696	112.29 ± 11.38	73.96 ± 7.33	42.78 ± 6.777	112.83± 10.69	74.36 ± 6.66
15	51.83 ± 7.997	114.04 ± 11.38	74.49 ±6.14	43.77 ± 8.333	111.91 ± 11.99	74.03 ± 7.59	47.99 ± 9.089	113.02 ± 11.70	74.27 ± 6.86
16	51.41 ± 7.902	115.17 ± 11.64	75.05 ± 6.16	46.29 ± 8.591	114.07 ± 12.525	76.51 ± 6.31	49.63 ± 8.481	114.78 ± 11.92	75.56± 65.34

TABLE -7

Mean scores Height and blood pressure of male and female children based on age

Age in yrs	Male			Female			Total		
	Height mean ± SD	Systolic mean ± SD	Diastolic mean ± SD	Height mean ± SD	Systolic mean ± SD	Diastolic mean ± SD	Height mean ± SD	Systolic mean ± SD	Diatolic mean ± SD
12	140.75±7.46	112.58± 9.91	74.25 ± 5.11	149.49 ± 6.93	107.61 ± 10.45	69.85 ± 8.64	145.84 ± 8.34	109.69 ± 10.48	71.69 ±7.66
13	143.19±7.12	113.58± 9.73	73.46 ± 6.44	150.09 ± 6.63	109.06 ± 11.11	72.23 ± 7.76	147.66 ± 7.55	110.69 ± 10.84	72.66 ± 7.32
14	148.29±7.27	113.48± 9.78	74.84 ± 5.72	152.96 ± 5.52	112.29 ± 11.38	73.96 ± 7.33	150.85 ± 6.77	112.83 ± 10.69	74.36 ± 6.66
15	158.01±8.55	114.04± 11.38	74.49 ±6.14	154.45 ± 6.74	111.91 ± 11.99	74.03 ± 7.59	156.32 ± 7.93	113.02 ± 11.70	74.27 ± 6.86
16	157.94±7.47	115.17 ± 11.64	75.05 ± 6.16	155.53 ± 4.82	114.07± 12.525	76.51 ± 6.31	157.10 ± 6.31	114.78 ± 11.92	75.56 ± 65.34

TABLE -8

Mean scores of Blood Pressure of male and female children based on BMI

	BMI Category	Male		Female		Total	
		Mo. of Males	BP mean ± SD	No. of Female	BP mean ± SD	No. of Children	BP mean ± SD
SYSTOLIC	Normal	410	113.61 ± 10.14	424	111.28 ± 11.21	834	112.43±10.75
	Over weight	53	117.66 ± 12.99	30	116.73 ± 12.22	83	117.33±12.65
	Obese	6	118.33 ± 13.48	6	123 ± 13.00	12	120.67±13.25
	Under weight	41	112.05 ± 11.83	90	107.42 ± 12.04	131	108.87±12.12
DIASTOLIC	Normal	410	74.43 ± 5.95	410	73.56 ± 7.59	834	73.99±6.84
	Over weight	53	75.17 ± 6.46	30	75.93 ± 6.95	83	75.45±6.61
	Obese	6	76.33 ± 5.16	6	80.67 ± 6.53	12	78.50±6.79
	Under weight	41	74.88 ± 6.01	90	71.00 ± 8.16	131	72.21±7.74

TABLE -9

Table showing type of hypertension in various age groups

	12 yrs		**13 yrs**		**14 yrs**		**15 yrs**		**16 yrs**	
	Male	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**
Normal BP	40	51	60	104	112	127	139	124	88	50
Systolic HT	6	3	5	5	8	10	11	8	6	2
Diastolic HT	0	1	0	0	1	0	0	2	0	0
Both	0	2	1	5	2	3	5	3	2	1
Low BP	2	10	1	9	5	16	9	12	7	2
Chisquare Value	7.735 N.S.		4.782 N.S.		5.418 N.S.		3.547 N.S.		1.094 N.S.	

Figure -4

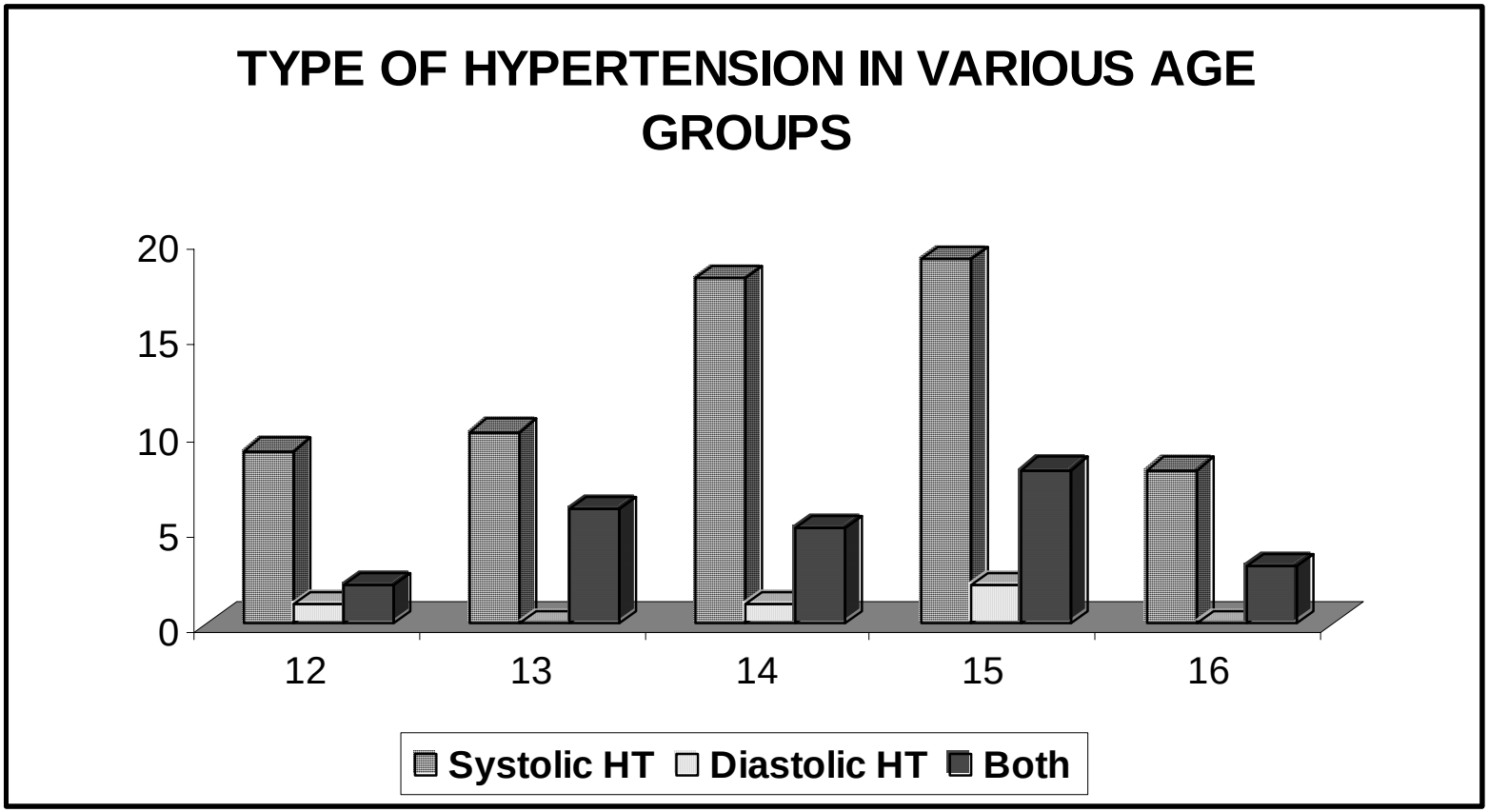
TYPE OF HYPERTENSION IN VARIOUS AGE GROUPS
20
15
10
5
0
12
13
14
15
16
Systolic HT
Diastolic HT
Both

TABLE -10

Age Related Hypertension

Age	Male			Female		
	Total	HT	%	Total	HT	%
12	48	6	125	67	6	8.95
13	67	6	8.95	123	10	8.13
14	128	11	8.59	156	13	8.33
15	164	16	9.75	149	13	8.72
16	103	8	7.76	55	3	5.45

TABLE -11

Association between BMI & Gender of Hypertensive individuals

BMI	Male			Female			Total		
Category	Total	HT	%	Total	HT	%	Total	HT	%
Normal	410	33	8.00	424	31	7.31	834	64	7.67
Over weight	53	10	33.33	30	5	16.66	83	15	18.07
Obese	6	1	16.66	6	3	50.00	12	4	33.33
Under weight	41	5	12.19	90	4	4.4%	131	9	6.87

Applying X^2 – Chisquare test

P. Value < 0.001

Highly Significant

TABLE -12

Association of BP with Family History and Socio Economic Status

B.P. Category	Family History				S.E. Status	
	HT	DM	HT+DM	NIL	Low	Middle
Normal	150	44	14	687	487	408
Systolic Hypertension	19	5	10	30	25	39
Diastolic Hypertension	2	1	0	1	2	2
Both	3	3	1	17	15	24
Low BP	9	6	2	56	27	73
Chi Square Value	71.939 P < 0.01				10.800 P<0.005	

TABLE -13

Relationship between BMI and Blood Pressure

	Systolic BP		Diastolic BP	
	Male	Female	Male	Female
12	.322*	.363**	.203	.185
13	.299	.066	-.051	.056
14	.055	-.249**	-.159	.242
15	.066	.330**	-.002	.299**
16	-.040	.468**	-0.23	.488**

*Correlation is significant at 0.05 level

** Correlation is significant at 0.01 level

TABLE -14

No. of Children Studied	No. of Children with Hypertension	Percentage
1060	92	8.67%

TABLE -15

Comparison of BMI and Blood Pressure between the low and Middle Socio Economic Status

	Low SE. n=569	Middle SE. n= 491	't' Value	'p' Value
	Mean ±SD	mean ±SD		
Weight	43.47±8.53	45.59±8.80	3.779	<0.01
Height	152.03±8.21	152.58±884	3.779	NS
BMI	19.09±6.77	19.64±3.48	1.626	NS
Sys. BP	111.62±10.87	113.40±11.66	2.565	<0.01
Diast BP	73.44±6.86	74.46±7.08	2.377	<0.05

TABLE -16

Effect of Family history of HT & DM on BMI and blood pressure of children

ANOVA

	'f' value	**Significance**
Weight	2.326	NS
Height	1.270	NS
BMI	0.484	NS
Sys. BP	8.826	1%
Dias. BP	3.542	1%

DISCUSSION

Hypertension is a major risk factor for cardiovascular[15] ,[16] and Cerebrovascular diseases. Petrovitch et al.,[17] Most of the studies of BP carried out in different populations have shown a rise of BP with age.[18] Kotchen et al.,[19] The insidious and steady course of hypertension in adults, indicates that it may have its roots in childhood and adolescent age group but probably goes undetected.Aggarwal et al.,[20] Recent work suggests, however that Blood pressure level correlates better with bodymass index in children and adolescents than with age. It is not clear what level of pressure should be considered distinctly abnormal at a given age or size. The prevalence of hypertension in children is reported to range form 1.0 to 16.2%. (Gupta et al.,[13] Hahn et al.,[21] Szklo et al.,[22] Suchidev et al.,[23]Chadha S.L.Tandon et al.,[24]). In the above studies the high incidence of hypertension may be due to inclusion of transient hypertension. Hypertension was defined as blood pressure above the 95th percentile on 3 different occasions.

Many authors agree that serial determination of blood pressure is necessary in order to document persistent elevations. Ramesh et al.,[25] Kilcoyne et al.,[26] Sustained severe hypertension can almost always be related to a definite cause however population based epidemiological studies show that primary hypertension is predominant among apparently healthy children. Aggarwal et al[20] In interpreting various data it must be recognized that

various definitions have been used to identify hypertension in adolescents and that re-screening has resulted in lower prevalence rate in several studies.

In order to study the variations in blood pressure over various ages it is necessary to study the normal range of blood pressure among children.

A considerable work has been done in different parts of India to establish the normal blood pressure variation for different age groups. (Aggarwal et al.,[20] Chahar et al.,[29] Gupta and Ahamed et al.,[13] Verma et al.,[30] Anand and Tandon et al.,[31] Chadha et al.,[24]) However very few studies are available with reference to blood pressure among children in Chennai.

A total of 1060 cases in age groups of 12 -16 years of age were tabulated in Table 1. Highest no of cases were studied in the age group of 15 years, lowest number in age group of 12 years.

The mean blood pressure levels of systolic and diastolic pressure of the 1060 children were studied in relation to age in both sexes. Blood pressure levels increases progressively with age.

The gradual increase in mean systolic pressure and mean diastolic pressure of boys and girls with age as noted by us agrees with the findings of the Task Force Committee report and other workers .Dubest Londe et al.,[28].

The mean systolic pressure of males for various age groups are higher than females. The difference in mean diastolic pressure between males and females are negligible.

In Indian school children an increase in systolic Blood pressure and Diastolic blood pressure has also been reported by various authors. (Chahar et al[29], Verma et al[30] Anand and Tandon[31] , Chadha et al[24]).

In the present study the value of systolic blood pressure and diastolic BP is slightly lower among girls than boys, but the differences were not found statistically significant in most of the age groups. This is consistent with findings of Laroia et al.,[32] Voors et al[33], Anand and Tandon et al[31], Chadha et al[24].

The prevalence of hypertension in school children of Chennai is 9.21% in boys and 8.18% in girls. According to Chadha et al.,[24] the prevalence of hypertension in Delhi school children of age 5 – 14 years is 11.7% Anjana, Prabhjot et al.,[34] reported the prevalence of 7.5% in boys and 6.52% in girls of Amritsar. But Chahar et al.,[29], Aggarwal et al[35] and Anand and Tandon[31] reported a low prevalence of hypertension i.e. 0.41 – 3.5% among school children. The reason for low prevalence of hypertension in these populations according to Chadha et al.,[24] is mainly the use of arbitrary criterion of hypertension assessment and not the recognized criterion of 95th percentile of blood pressure values.

In the present sample sex differences in the prevalence of hypertension were not statistically significant ($P>0.05$). The finding that there are no appreciable sex differences in the prevalence of hypertension among school

children has also been observed by Chadha et al.,[24], Anand and Tandon et al.,[31] and Voors et al.,[33].

In our study the prevalence of overweight was 7.83% and obesity was 1.1% which was in comparable with study done by Bisavmohan et al.,[36] with 11.63% of overweight and 2.35% obese in urban areas but our study group comprises of subjects from middle and lower socio economic status.

The overall prevalence of hypertension in overweight children is 18.07% (n = 15) and in obese children it is 33.33% (n = 4). The prevalence of hypertension in children with normal body mass index was 7.67% (n = 64). The mean body mass index of hypertension population was significantly higher than respective normotensive population.

The mean systolic and diastolic BP of overweight and obese children is higher than their normotensive counterparts.

The correlation of BMI with hypertension shows a statistical significance of ($P < 0.001$).

The prevalence of overweight and obesity in children aged between 6 to 17 yrs in all ethnic groups is reported to be between 5 – 30%. Abdurrahman et al.,[37]. Kapil et al.,[38] reported prevalence of obesity in adolescent school children of affluent families to 7.4% and overweight 23.1% similar prevalence of obesity and overweight was observed by Gupta and Ahamed et al.,[13]. High incidence of obesity and overweight reported by Kapil

et al.,[38] is probably due to selection of different populations (affluent families children).

In our present study reported prevalence is 7.83% of overweight and 1.1% of obese children. The United States National Centre for Health Statistics suggests that nearly 15% of adolescents are over weight or obese[39].

There is evidence that children and adolescents are becoming overweight possibly because of decreased physical activity, sedentary lifestyle, altered eating pattern, and increased fat content of diet.[13]

Hypertension in obese children may occur due to increased cardiac output, excessive sodium intake, increased steroid production and alteration in response for various pressor substances. Whyte et al.,[40] Alexander et al.,[41] Dahl et al.,[42]

In our study the correlation of hypertension in children is strongly associated ($P < 0.001$) with family history of hypertension or hypertension with diabetes which has also figured in study done by Gupta and Ahamed and by other workers also. Leoine et al.,[43] Gupta et al.,[44].

The family history of hypertension does not has a significant association with overweight or obese status of the child. The prevalence of hypertension in middle socio economic status when compared to lower socio economic status show a significant association ($P<0.05$).

This indicates a direct relationship of hypertension influenced by obesity, overweight, family H/o hypertension and diabetes and socio economics status.

CONCLUSION

1. Blood pressure readings taken in various schools from middle and lower socio economic groups were tabulated for boys and girls in 12 – 16 yrs age group. Mean systolic and diastolic pressure showed linear relationship with age. There was no significant difference in mean systolic and diastolic blood pressure between both sexes.

2. There was a highly statistically significant difference between mean systolic and diastolic blood pressure between lower and middle socio economic class.

3. Mean systolic and diastolic blood pressure for both sexes increased with increase in weight and height.

4. Prevalence of hypertension was 8.67% and the children were adviced follow up at Government Royapettah hospital.

5. Prevalence of obesity in our study was 1.13%, overweight was 7.83%. Prevalence of hypertension in obese children was 33.33% and in Overweight children 18.07%.

6. The Prevalence of Underweight children was 12.35% which was high as the population studied comprises of children belonging to Middle and Lower Socio-Economic Status. The Prevalence of

hypertension in these children (6.87%) was less than that of children belonging to normal weight group (7.67%).

7. Family history of hypertension and diabetes carry a significant correlation with elevated systolic and diastolic blood pressure in adolescents.

RECOMMENDATIONS

The conventional mercury sphygmomanometer is used to record to blood pressure in all children above 3 yrs with appropriate sized cuff annually.

From this study it is evident that socio economic factors play a significant role in determining the blood pressure of the individual. Children of middle class have significantly elevated mean systolic pressure and mean diastolic pressure than low socio economic groups.

There is a slight difference noticed between both sexes in relationship to age, blood pressure, body man index but this is not significant. Values > 2SD which correspond to 95^{th} percentile measured on 3 different occasions can be taken as hypertensive.

So the blood pressure measurements in children is an important clinical examination like recording pulse rate and respiratory rate. It is a continuously distributed variable like height and weight. So it should be recorded atleast once a year so as to identify hypertension at an early stage.

The prevalence of overweight and obesity are increasing even in lower and middle socio economic groups which is very alarming, and is mainly due to decreased physical activity and junk food consumption.

It would be logical to advise families with obese children to change their lifestyle with respect to diet, exercise, and reduced salt intake to get their children accustomed to lifestyle which are favourable for maintenance of normal blood pressure. The potential benefits by way of prevention is enormous in terms of later cardiovascular diseases and its associated morbidity and mortality which allows the provision of more comprehensive care to the paediatric population.

ANNEXURE – I

PROFORMA

Department of Paediatrics, Govt Royapettah Hospital

Kilpauk Medical College, Chennai – 10

Evaluation of Blood Pressure in Adolescent School Children

1. S.No. :

2. Name :

3. Age :

4. Sex :

5. School :

6. Residence :

7. Father's Educational Status :

8. Father's Occupation :

9. Father's income :

10. Measurement

Height (Cms) :

Weight (Kgs) :

BMI :

11. Nutritional Status :

12. Pulse rate

Volume :

Character :

13. Pallor

Facial puffiness :

Abdominal distension :

Pedal edema :

Skin infection :

14. Blood pressure measurement

	Systolic	Diastolic
1		
2		
3		
Average		

15. If Hypertensive further evaluation at GRH.

ANNEXURE – II

SOCIO-ECONOMIC STATUS SCALE

Modified Kuppuswami Scale

A	Education	Score
1.	Professional Degree	7
2.	BA, B.Sc. Degree	6
3.	Higher Secondary	5
4.	High School	4
5.	Middle School	3
6.	Primary School / Literate	2
7.	Illiterate	1
B.	**Occupation**	
1.	Professional	10
2.	Semi-Profession	6
3.	Clerical	5
4.	Skilled worker	4
5.	Semiskilled worker	3
6.	Unskilled worker	2
7.	Unemployed	1
C.	**Income(Mon. per capita)**	
1.	Rs.3000 and above	10
2.	Rs. 2001-3000	6
3.	Rs. 1501-2000	5
4.	Rs. 1001 – 1500	4
5.	Rs. 501 – 1000	3
6.	Rs. 201-500	2
7.	Rs. <200	1

Total Score	Socio Economic Status
26-27	Class I (Upper)
16-25	Class II (Upper middle)
11-15	Class III (Lower middle)
5-10	Class IV (Upper lower)
<5	Class V (Lower)

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